

**Marked-Up Version of Substitute Specification****Description**

5      ~~Circuit arrangement for a multimode mobile telephone for~~  
~~transmitting/receiving signals to/from various mobile radio networks.~~

**CIRCUIT ARRANGEMENT FOR A MULTIMODE MOBILE**  
**TELEPHONE FOR TRANSMITTING/RECEIVING SIGNALS TO/FROM**  
**VARIOUS MOBILE RADIO NETWORKS**

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**BACKGROUND**

15      The ~~invention~~ present disclosure relates to ~~a circuit arrangements~~ for a multimode mobile telephone for transmitting/receiving signals to/from various mobile radio networks, ~~with a baseband in which at least two analog digital converters and one digital analog converter are arranged, and a transceiver unit in which at least a first receiver and a second receiver and at least one transmitter amplifier are arranged, with connections between the outputs of the receivers and the analog digital converters and a connection between the input of the transmitter amplifier and the digital analog converter, and also connections between the inputs of the first and second receiver, the output of the transmitter amplifier and an antenna changeover switch, with the antenna changeover switch being connected to a transmitting and receiving antenna, and furthermore means being provided for performing a digital adaptive predistortion.~~

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30      In many fields, such as with multimode mobile telephones, a linear signal amplification with a high output efficiency is required. One possibility way of achieving a linear signal amplification is to fit combine a non-linear power amplifier (PA), ~~i.e. that has a non-linear curve, before a system, thewith a~~ predistorter. The predistorter distorts the input signals so that the complete system consisting of a predistorter and nonlinear power amplifier again has a substantially

more linear behavior than just a power amplifier. This method of application is known as predistortion. The combination of the predistorter curve of the input signal and the non-linear amplification curve results overall in a linear curve of the transmitting system and thus a linear signal amplification. One problem with this method of application occurs due to the ageing of components or the temperature-dependence of components. These effects of such phenomena in turn change the linearity of the transmission system.

To correct these undesirable effects, ~~with~~ using digital adaptive predistortion, the envelope of the amplified signal is regained with the aid of a measuring branch, ~~the or~~ feedback branch. ~~An adaptation of t~~ The curve of the predistorter is then carried out accordingly adapted. ~~This~~ The feedback branch consists mainly of a coupler, a demodulator and an analog-digital converter (ADC).

A disadvantage of this method of digital adaptive predistortion is that the feedback branch involves additional costs, installation space and power consumption. For this reason, no linearization methods for power amplifiers requiring a complex feedback branch have so far been realized in commercial systems.

## SUMMARY

~~It is therefore the object of the invention to provide~~ The present disclosure teaches a circuit arrangement for a multimode mobile telephone that enables digital adaptive predistortion, without using additional hardware components for the feedback branch.

~~This object is achieved by the features of the independent Claim 1.~~  
~~Advantageous developments of the invention are the object of subordinate claims.~~

The ~~inventors have, on one hand, recognized that e~~Existing hardware components of a ~~known~~an exemplary circuit arrangement for a multimode mobile telephone are not continually used for their intended tasks, and on the other hand, that these existing hardware components are also suitable for functioning as a  
5 feedback branch in the context of digital adaptive predistortion.

In one exemplary embodiment, a circuit arrangement for a multimode mobile telephone that transmits and receives signals to and from various mobile radio networks contains a baseband and a transceiver unit. The baseband includes  
10 at least two analog to digital converters and at least one digital to analog converter.  
The transceiver unit includes at least two receivers and at least one transmitter amplifier. The transceiver also includes a antenna changeover switch and a transmitting and receiving antenna. An output of each receiver is connected to one of the analog to digital converters. The digital to analog converter is connected to  
15 an input of the transmitter amplifier. The antenna changeover switch is connected to the inputs of the two receivers and to the output of the transmitter amplifier. The antenna changeover switch is also connected to the transmitting and receiving antenna.

20 One element of this exemplary embodiment is a digital adaptive predistorter having a switching element. The switching element is arranged so that an optional connection is created. The optional connection connects the amplifier output to one of the receiver inputs causing that receiver input to be disconnected from the antenna changeover switch. This way, it is possible for the receiver to be  
25 disconnected from the transmitting and receiving antenna during periods when the receiver is not receiving signals from the transmitting and receiving antenna. While the receiver is disconnected from the transmitting and receiving antenna, the receiver is able to receive other signals. By using a simple switch the receiver can be disconnected from the transmitting and receiving antenna, and at the same time  
30 establish a connection between the output of the transmitter amplifier and the input of the receiver. By doing so, the receiver is able to tap off and detect signals at the

output of the transmitter amplifier. Corresponding to the general concept of the invention, the inventors propose an existing circuit arrangement for a multimode mobile telephone for transmitting/receiving signals to/from various mobile radio networks with: a baseband, in which at least two analog-digital converters and one digital-analog converter are arranged, a transceiver unit, in which at least a first receiver and a second receiver and at least one transmitter amplifier are arranged, there being connections both between the outputs of the receivers and the analog-digital converters, and a connection between the input of the transmitter amplifier and the digital-analog converter, and also connections between the inputs of the first receiver, of the second receiver, the output of the transmitter amplifier and an antenna changeover switch, the antenna changeover switch being connected to a transmitting and receiving antenna, and, furthermore, means being provided for performing a digital adaptive predistortion, so that at least one switching element of that kind is arranged in such a way between the output of the transmitter amplifier, of which there is at least one, and the input of the second receiver, that optionally a connection is created that connects the output of the transmitter amplifier, of which there is at least one, with the input of the second receiver and at the same time disconnects the connection between the input of this second receiver and the antenna changeover switch.

In this way, it is possible for the second receiver to be disconnected from the transmitting and receiving antenna during the periods when it is receiving no signals from the transmitting and receiving antenna and therefore to be able to receive other signals. It is therefore possible, by means of a simple switch which in one position of the switch disconnects the second receiver from the transmitting and receiving antenna and at the same time establishes a connection between the output of the transmitter amplifier and the input of the second receiver, for the signals at the output of the transmitter amplifier to be tapped off and detected by the second receiver.

~~It is particularly favorable if~~Under a preferred embodiment, at least one switch element is arranged in the antenna changeover switch. ~~Thus~~Under this configuration, a separation of the transmitted and received signals with regard to frequency and time takes place in the antenna changeover switch. Certain switching functions are integrated into the antenna changeover switch for these tasks. A particularly advantageous variant for the switching device is proposed by aAdditional integration of the switch element in the antenna changeover switch may also be performed without deviating from the spirit and scope of the invention.

10 ~~It is particularly advantageous if at least~~If a first receiver receives signals transmitted from the a UMTS network and the a second receiver, of which there is at least one, receives signals transmitted from the a GSM network, Thus, the first receiver can always be available for reception from the UMTS network, while theThe second receiver, that which monitors the GSM network only at  
15 timesperiodically, measures the signal at the transmitter amplifier output in at the time in which no signals are received from the GSM network. TheAccordingly, the second receiver should thuswould meet the requirements for a UMTS predistortion and also for GSM reception, i.e. this receiver should be reconfigurable. In this way, the existing hardware components, that at certain times are not used, can be more  
20 effectively utilized and no additional hardware components, involving extra cost and installation space, need to be fitted in the circuit arrangement.

Additional features and advantages of the invention are given in the following description of preferred exemplary embodiments, with reference to the  
25 drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**~~The invention is explained in more detail in the following with the aid of the drawings.~~

Figure 1: ~~Known~~ illustrates a prior art circuit arrangement for multimode mobile telephones in which a digital adaptive predistortion is performed with the aid of a feedback branch

5        Figure 2: ~~is a~~ circuit arrangement for multimode mobile telephones in which digital adaptive predistortion is performed with one of two receivers.

### DETAILED DESCRIPTION

10        Figure 1 shows a known circuit arrangement for multimode mobile telephones, in which digital adaptive predistortion is performed with the aid of a feedback branch 5. This circuit arrangement consists ~~essentially~~ of a transceiver unit 2 and a unit designated as baseband 1, in which the signal predistortion necessary for the digital adaptive predistortion method takes place.

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      The transceiver unit 2, shown in Figure 1 by a box with a dotted frame, consists of a transmitting and receiving antenna 8 that, by means of an antenna changeover switch 10, has connections 13.1, 13.2 and 14 ~~in each case, coupled~~ to inputs 19.1 and 19.2 of both receivers (RX 1 and RX 2) 3.1 and 3.2, and to output 20 of the transmitter amplifier (TX) 4. In this embodiment, the receiver 3.1 (RX 1) and the transmitter amplifier 4 (TX) ~~are suitable for signal reception from, and signal transmission to, communicate with~~ the UMTS network. ~~This is the known~~ The communication follows the FDD-UMTS (Frequency Division Duplex-Universal Mobile Telecommunication System) standard, whereby several frequency bands are used. The several frequency bands ~~in this case means that provides for~~ simultaneous transmitting and receiving of signals on the various frequency bands, as well as modulation of ~~is possible, with it being possible to modulate~~ the amplitude and phase of the signals. The GSM (Global System Mobile) network is monitored by receiver 3.2 (RX 2). In the GSM network, the signals are transmitted in time slots, and are phase-modulated using the time-division multiplex method. ~~Simultaneous~~ Unlike FDD-UMTS, simultaneous transmission and reception of signals is not

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possible in the GSM network. The frequency and timing of the signals transmitted and received via the transmitting and receiving antenna 8 can be separated by means of the antenna changeover switch 10.

5        ~~The~~ Baseband 1 is shown within the dotted box on the left in Figure 1. The ~~b~~Baseband 1 has a total of three analog-digital converters 6.1 to 6.3 and a digital-analog converter 7. Both top analog-digital converters 6.1 and 6.2 each receive analog signals via connections 11.1 and 11.2 transmitted from the outputs 17.1 and 17.2 of the first and second receivers (RX 1 and RX 2) 3.1 and 3.2. In order to be  
10        able to perform digital adaptive predistortion with this circuit arrangement, the lowest digital-analog converter 7 is provided in baseband 1 that transmits the predistorted signals via connection 12 to the input 18 of the transmitter amplifier 4 (TX).

15        To obtain linear signal amplification ~~with this circuit arrangement~~ under the arrangement of Figure 1, the a predistorted signal fed in via connection 12 to input 18 of the transmitter amplifier (TX) 4 and predistorted must be tapped off at output 20 of the transmitter amplifier (TX) 4 and compared with the fed-in signal.

20        ~~To this, a branch 15, as a~~ A measuring branch 15, is provided at the output 20 of the transmitter amplifier (TX) 4. This measuring branch, also known as a feedback branch 5, ~~also~~ uses the lowest analog-digital converter 6.3. By comparing the signal fed in at input 18 with the signal output at output 20, non-linearities of the signal amplification can be detected and subsequently corrected.

25        Figure 2 shows a ~~new~~ different circuit arrangement for multimode mobile telephones in which a digital adaptive predistortion can be performed with one receiver (RX 2) 3.2 ~~of from~~ two available receivers (RX 1 and RX 2) 3.1 and 3.2. Similar to Figure 1, ~~this the~~ the circuit arrangement of Figure 2 ~~consists essentially~~  
30        of comprises a transceiver unit 2 and a unit designated as baseband 1.

Similar to Figure 1, ~~the~~ transceiver unit 2 ~~consists of~~ comprises a transmitting and receiving antenna 8 that, ~~via antenna changeover switch 10,~~ has connections 13.1, 13.2 and 14 coupled to both inputs 19.1 and 19.2 of the receivers (RX 1 and RX 2) 3.1 and 3.2 via changeover switch 10 respectively and further to the output 20 of the transmitter amplifier (TX) 4. ~~In this embodiment~~ Under this configuration, the receiver 3.1 (RX 1) and the transmitter amplifier 4 (TX) are ~~suitable for signal reception and signal~~ can effectively communicate with transmission to the UMTS network. ~~This is the known under the FDD-UMTS (Frequency Division Duplex-Universal Mobile Telecommunication System) standard, whereby several frequency bands are used. By means of the~~ using several frequency bands, simultaneous transmission and reception of signals on the different frequency bands is possible ~~in this case, with and~~ modulation of the amplitude and phase of the signals ~~being possible~~ can occur. ~~The~~ A GSM (Global System Mobile) network is monitored by the second receiver 3.2 (RX 2). ~~In~~ Under the GSM network, the signals are transmitted in time slots, and phase-modulated using the time-division multiplex method. Simultaneous transmission and reception of signals is not possible ~~in under~~ the GSM network. By means of the antenna changeover switch 10, the signals received and transmitted via the transmitting and receiving antenna 8 are separated with respect to frequency and time.

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In contrast to Figure 1, no separate feedback branch 5 is provided in the new circuit arrangement of Figure 2 at the output of the transmitter amplifier (TX) 4 for monitoring the signal at the output 20 of the transmitter amplifier (TX) 4. The absence of the feedback branch 5 can mean that the analog-digital converter 6.3 (lowest ADC from Figure 1) in the baseband 1 that was previously necessary can now be omitted.

Referring to Figure 2, switch 9 is coupled to the circuit arrangement to enable the detection of ~~In order, nevertheless, to be able to detect~~ the signal at output 20 of the transmitter amplifier (TX) 4 ~~with the new circuit arrangement, a switch 9 is fitted.~~ When the switch 9 is in switch setting II, the input 19.2 of the

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receiver (RX 2) 3.2 is connected, via the optional connection 13.2', to the antenna  
changeover switch 10 and the transmitting and receiving antenna 8. The GSM  
network can thus be monitored in switch setting II. As described above, in the GSM  
network the signals are transmitted in time slots, phase-modulated using the time-  
5 division multiplex method.

That means that it is now possible in these time slots, in which no GSM  
signals are transmitted, to input 19.2 of the receiver (RX 2) 3.2, and to use ~~this~~  
receiver (RX 2) 3.2 to monitor the signals ~~that are output~~ at output 20 of the  
10 transmitter amplifier (TX) 4. To do this, the switch 9 is moved to switch setting I in  
these time slots, creating and thus the optional connection 13.2' between the second  
receiver (RX 2) 3.2 and the antenna changeover switch 10. Changeover switch 10 is  
disconnected and at the same time the optional connection 16' from the output 20  
of the transmitter receiver (TX) 4 to the input 19.2 of the second receiver (RX 2)  
15 3.2 is established. The second receiver (RX 2) 3.2 and the analog-digital converter  
6.2 now function as a feedback branch.

~~Overall therefore, the invention presents~~The above disclosure illustrates a  
circuit arrangement for a multimode mobile telephone that enables digital adaptive  
20 predistortion to be carried out. In contrast to ~~previously~~the prior art discussed  
above, with this the disclosed circuit arrangement does not require an additional  
measuring branch ~~is not necessary~~ to measure the amplified signal, but instead ~~the~~  
utilizes existing hardware components of the circuit arrangement, and are switched  
in such a way that they have the same function as the measuring branch. Depending  
25 on the switch setting of the switching element, the second receiver is suitable for,  
for example, performing a UMTS predistortion and also suitable for GSM  
reception.

In addition, although the invention is described in connection with mobile  
30 telephones, it should be readily apparent that the invention may be practiced with  
any type of communicating device, such as a personal assistant or even a PC-

enabled device. It is also understood that the system devices described in the  
embodiments above can substituted with equivalent devices to perform the  
disclosed methods and processes. Accordingly, the invention is not limited by the  
foregoing description or drawings, but is only limited by the scope of the appended  
5 claims.~~It is obvious that these named features of the invention can be used not only~~  
~~in the particular combination given but also in other combinations or alone, without~~  
~~departing from the framework of the invention.~~

## List of reference characters

	1	Baseband
	2	Transceiver unit
5	3.1	First receiver RX 1
	3.2	Second receiver RX 2
	4	Transmitter amplifier TX
	5	Feedback branch
	6.1	Analog digital converter (ADC) of the first receiver RX 1
10	6.2	Analog digital converter (ADC) of the second receiver RX 2
	6.3	Analog digital converters (ADC) of the feedback branch
	7	Digital analog converter (DAC) of the transmitter amplifier TX
	8	Transmitting and receiving antenna
	9	Switch with two switch settings I and II
15	10	Antenna changeover switch/Front End (FE)
	11.1	Connection of the output of the first receiver RX 1 to the analog digital converter 6.1
	11.2	Connection of the output of the second receiver RX 2 to the analog digital converter 6.2
20	11.3	Connection of the feedback branch to the analog digital converter 6.3
	12	Connection of the digital analog converter with the input of the transmitter amplifier TX
	13.1	Connection of the antenna changeover switch to the input of the first receiver RX 1
25	13.2	Connection of the antenna changeover switch to the input of the second receiver RX 2

- 13.2' ——— Optional connection of the antenna changeover switch to the input of  
the second receiver RX 2
- 14 ——— Connection of the output of the transmitter amplifier TX to the  
antenna changeover switch
- 5 15 ——— Branch of the output of the transmitter amplifier TX to the feedback  
branch
- 16' ——— Optional connection of the output of the transmitter receiver TX to  
the input of the second receiver RX 2
- 17.1 ——— Output of the first receiver RX 1
- 10 17.2 ——— Output of the second receiver RX 2
- 18 ——— Input of the transmitter amplifier TX
- 19.1 ——— Input of the first receiver RX 1
- 19.2 ——— Input of the second receiver RX 2
- 20 ——— Output of the transmitter amplifier TX
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## **ABSTRACT OF THE DISCLOSURE**

A circuit arrangement for a multimode mobile telephone that transmits and receives signals to and from various mobile radio networks contains a baseband and  
5 a transceiver unit. The transceiver unit includes a digital adaptive predistorter having a switching element. The switching element is arranged so that an optional connection is created. The optional connection connects an amplifier output to an input of a receiver causing that receiver input to be disconnected from an antenna  
10 changeover switch. This way, it is possible for the receiver to be disconnected from a transmitting and receiving antenna during periods when the receiver is not receiving signals from the transmitting and receiving antenna. While the receiver is disconnected from the transmitting and receiving antenna, the receiver is able to  
15 receive other signals. By using a simple switch the receiver can be disconnected from the transmitting and receiving antenna, and at the same time establish a connection between the output of the transmitter amplifier and the input of the  
receiver. By doing so, the receiver is able to tap off and detect signals at the output of the transmitter amplifier.